4.20 SCHMIDT TRIGGER

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The Schmidt trigger is essentially a not gate, but because of its memory capability it is often classified as a sequential logic circuit. The basic building block of the sequential logic is the flip-flop. The Schmidt is generally not considered to be a flip-flop, however some electronic textbooks list it under "flip-flop" because of the similar characteristics.

The Schmidt trigger is basically used for two things: threshold detection and signal conditioning. We will take a quick look at these two applications and how rise and fall times determine the transition speed and the affect threshold detection and signal conditioning have on wave shaping. Then we will venture into the undefined region and explore the switching threshold.

Rise and Fall Times

A Schmidt trigger is a bistable (two-state) device used to square-up waveforms with slow rise and fall times. By design, digital circuits prefer wave forms with fast rise and fall times. An oscillating waveform can distort data if fed directly into a digital circuit. The output signal would be erratic and unreliable. The Schmidt trigger's purpose is to convert these slow, erratic signals into square waves with rapid transition times, approximately 10 nano seconds.

Signal Conditioning

the Schmidt trigger converts a slow input signal to a faster output signal by speeding up the transition times. By changing the transition time of the input signal the trigger is actually reshaping the waveform into a square waveform. The vertical rise and fall time of the output waveform indicates that it changes logic states at an almost instantaneous rate. This sine-to-square wave conversion is referred to as ***signal conditioning.***

Switching Threshold

The ***switching threshold*** is the point where the signal changes logic states. The trigger's memory capability allows it to maintain a logic state until it passes the threshold point. The threshold or trip point may differ depending on the IC chip, but it will always be in the undefined region. The difference between the two thresholds is called the ***hystersis zone***. Besides preventing unwanted oscillation, this zone also provides noise immunity.

The switching threshold will vary from one logic family to another. Some gates have a single trip point. An example of an IC with a single threshold is the TTL 7404. Because this type of circuit only has one trip point, the voltage tends to oscillate when the input is too close to the threshold.

The Schmidt trigger has two thresholds. A positive going threshold (Vt+) and a negative going threshold (Vt-). A low signal will not change states until it passes the positive going threshold (1.7V). A high signal that passes into the hystersis zone will remain high until it reaches the negative going threshold (0.9V).

Inverters

Standard vs. Schmidt Trigger

The problem with ***standard inverters*** is that they are dependent on the transition time of the input signal. If the signal is too slow, oscillation may occur. The result is an erratic triggering pattern that produces unreliable logic states. Some examples of standard inverters are Dual Quad input NAND's such as models 7413, 74LS13, and 74HC13.

The ***Schmidt trigger inverter*** is not a slave to transition times like the standard inverter. The reason for this is the hysteresis zone. It is the key to the schmitt's reliable response to slow changing input signals. It prevents oscillation when switching

logic states resulting in a clean, fast signal that is independent of input transition time. Some examples of IC's with schmitt trigger inputs are Hex Inverter IC's such as 7414, 74LS14, and 74HC14.

Conclusion

The most common applications of the schmitt trigger are threshold detection and signal conditioning. The output is independent of the source signal. Speeding up the transition (rise and fall) time affects the shape of the waveform. The result is a reliable, oscillation-free digital signal that can drive standard standard IC devices.